PATENT SPECIFICATION

DRAWINGS ATTACHED

902,069

Date of Application and filing Complete Specification: Jan. 3, 1961.

No. 200/61.

Application made in United States of America (No. 25118) on April 27, 1960.

Complete Specification Published: July 25, 1962.

Index at acceptance:—Class 83(3), B2(A1:K8:P1:R:Y1), D4(A4:B20C), W8.

International Classification:—B23b.

COMPLETE SPECIFICATION

Machine Tools

We, THE NEW BRITAIN MACHINE COMPANY, a corporation organised under the laws of the State of Connecticut, United States of America, of South Street, New Britain, State of Connecticut, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to machine tools and more particularly to combined boring, drilling and milling machines.

Programmed controls for machine tools have been used for automatically effecting a number of machine operations on a workpiece. These controls perform predetermined cycles of machine operations utilizing a single tool. The present invention contemplates the use of different tools within machine cycles of operation and accordingly provides means automatically programming a series of machine operations utilizing one or more tools. Such means, as more fully disclosed hereinafter, is effective to align a tool carrying member such as a spindle and a predetermined one of a plurality of tool holding devices in a tool rack to permit the tool carrying member to receive one of the tools held by the tool holding devices.

Furthermore since the tools contemplated are of a rotating type, and since it is important with most of the types of tools used with machines of the character here involved, not only from the degree of accuracy attained, but for other well understood reasons that each tool be repeatedly connected to the spindle in exactly the same position, and also for the purpose of driving the tools, each of the tools is provided with a key adapted to fit in a keyway in the projecting end of the spindle. In order for the keys to properly engage the keyway in the spindle when the tools are picked up by the spindle it is important that the tools always be placed in the tool holding device of the tool rack with the keys in the same angular position and upon each stopping of the spindle preparatory to the depositing of the tool in a tool holding device of the rack or picking up a tool in the tool rack the spindle must be stopped in the same angular position.

It will be apparent that when the machine operation is automatically programmed and spindle rotation has been terminated under control of, for example, a tape or card control, the spindle may or may not stop at an angular position to permit pick up of a tool from or deposit of a tool in the tool holding device. In order to insure that the spindle will stop at the same angular position we further provide means, more fully disclosed hereinafter, operatively connected to the tool carrying member for stopping the tool carrying member i.e. the spindle, in substantially the same angular position each time its rotation is discontinued prior to depositing a tool or picking up a tool from the tool rack.

With the foregoing in mind it will be apparent that we provide, in accordance with the invention a machine tool having a rotatable tool carrying member adapted to have a tool detachably keyed thereto and a work carrying member movable relative to one another both transversely of the axis of rotation of the tool carrying member and lengthwise of said axis and capable of automatically performing a series of machining operations on one or more work pieces carried by the work carrying member, characterized by means for automatically programming a series of machine operations and being effective to align the tool carrying member and a predetermined one of a plurality of tool holding devices in a tool rack to permit the tool carrying member to receive one of the tools held by the tool holding devices, and means operatively connected to the tool carrying member for stopping said tool carrying member in substantially the same angular position each time its rotation is discontinued prior to depositing a tool or picking up a tool from the tool rack.

The objects and advantages of the inven-

[*Price 4s. 6d.*]

tion will be readily apparent from the following description of the preferred embodiment described with reference to the accompanying drawings forming a part of this specification, in which similar reference characters designate corresponding parts, and in which

Fig. 1 is a perspective view of a horizontal boring, drilling and milling machine embodying the present invention;

Fig. 2 is a fragmentary front elevational view of the spindle head of the machine shown in Fig. 1 with parts broken away and in section;

Fig. 3 is a sectional view approximately on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary and elevational view of the work carrying slide and tool magazine with parts broken away and in section;

Fig. 5 is an enlarged fragmentary sectional view of the right hand or tool carrying end of the tool spindle; and

Fig. 6 is an enlarged fragmentary sectional view of the left hand or rear end of the tool spindle.

Referring to the drawings of the machine shown therein a bed or base A, provided at one end with a column B having vertical ways 10 and 11 on its front side upon which a spindle head or slide member C is supported for vertical movement, a saddle or slide member D supported on two or more horizontal ways 12 formed on the upper side of the bed or base A for movement towards and from the column B and a work table or work carrying slide member E supported on horizontal ways 14 and 15 on the upper side of the saddle D for movement transversely of the bed A.

The spindle head C is adapted to be moved vertically along the ways 10 and 11 by a lead screw 16 rotatably supported in the base of the machine and having threaded engagement with a nut fixed in the spindle head. The spindle head C carries a horizontal spindle 17 which in addition to being rotatble in opposite directions, is movable in opposite directions longitudinally of its axis of rotation at different speeds to effect both feed and rapid or traverse movements of the tool carried thereby. The saddle D is movable in opposite directions longitudinally of the axis of rotation of the tool spindle along the ways 12 and the table E is movable in opposite directions transversely of the axis of rotation of the tool spindle along the ways 14 and 15 at different speeds to effect both feed and rapid or traverse movements by suitable mechanism.

In the normal operation of the machine the foregoing movements are effected by power and for this purpose the machine illustrated includes a reversible electric motor, generally referred to as the "spindle drive" motor, enclosed within the left-hand end of the base of the machine for effecting the spindle rotation and spindle feed movements, a reversible spindle rapid traverse electric motor mounted on the spindle head C, generally referred to as the "spindle traverse" motor and discrete multi-speed reversible electric motors, generally referred to as "feed" motors for effecting the feed and rapid or traverse movements of the spindle head, saddle and table. Other motors are employed but their location and operation are not necessary to an understanding of the present invention

The speed and direction of rotation of the spindle, and the speed and direction of movement of the other various machine tool elements, such as the feed and traverse movements of the spindle, spindle head, saddle and table are controlled either by an operator through the use of a plurality of manual controls located on a pendant control station G or automatically by a punched tape control unit H located at a convenient place about the machine. The machine will automatically perform any desired cycle of operations within its capacity in response to information placed on the tape.

The present invention contemplates extending the capacity of machines of the character referred to and machine tools generally, beyond those of merely performing predetermined cycles of machining operations utilizing a single tool, to include the performing of such cycles utilizing different tools with the tool selection and changing functions being performed automatically in response to information on the tape.

Referring again to the drawings, the machine illustrated comprises a tool rack K detachably connected to the upper right-hand front corner of the table E, as the machine is viewed in Fig. 1, which tool rack is provided with a plurality of tool holding devices L, each of which has a tool T therein with the exception of the sixth device from the bottom in the left-hand row, which tool, in the embodiment shown, has been transferred to the spindle 17 in position to drill a hole in a workpiece W carried by the table E and connected to the upper side thereof in a position offset rearwardly from the tool rack K.

According to the provisions of the present invention the required or desired machining operation or operations to be performed by the tool in the spindle are performed automatically and after they have been completed the tool and work are automatically separated to permit relative movement therebetween transversely of the axis of the spindle, the spindle head and table are then automatically moved to align the spindle with the tool holding device in the tool rack in which the tool in the spindle is normally positioned. After the spindle has been so aligned it is automatically extended, that is, moved in a forward direction, to locate the tool therein in the tool holding device in which it belongs to the rack K whereupon the clamp or tool grab means

in the tool spindle is automatically actuated to release the tool and the spindle automatically retracted.

With no tool in the spindle the spindle head and/or table are again automatically moved to align the spindle with any desired tool in the rack K whereupon the spindle is again automatically extended to engage the selected tool with the spindle and the clamp mechanism in the spindle automatically actuated to clamp or grab the tool. The spindle is subsequently automatically retracted and the spindle head and table automatically moved relative to one another to align the spindle with a position on the work at which a subsequent machining operation is to be performed. If two or more operations are to be performed by the same tool these operations are automatically carried out. After the desired machining operation or operations are performed by the tool then in the spindle the cycle of returning the tool to the rack K and picking up another tool is automatically repeated until all of the machining operations to be performed upon the work W are completed whereupon the last tool used is returned to the rack E and the machine automatically stopped.

The parts, heretofore referred to as tools, are in fact tool arbors having tools proper detachably connected therewith and since the tools used with machines of the character described are of the rotating type, including the milling cutter shown in the upper right-hand corner of the rack K, and since it is important with most of the types of tools used with machines of the character here involved, not only from the degree of accuracy attained, but for other well understood reasons that each tool be repeatedly connected to the spindle in exactly the same position, and since for the purpose of driving the tools, each of the arbors is provided with a key 18 adapted to fit in a keyway 19 in the projecting end of the spindle 17. In order for the keys to properly engage the keyway in the spindle when the tools are picked up by the spindle the tools are always placed in the tool holding device of the tool rack with the keys in the same angular position and upon each stopping of the spindle under the control of the punched tape, preparatory to the depositing of a tool in a tool holding device of rack K or picking up a tool in the tool rack the spindle must be stopped in the same angular position.

For the purpose of continuing the rotation of the spindle for a short time after the punch tape control has functioned to stop it, assuming such continued rotation is necessary to bring the spindle to a predetermined angular position so that it always stops in the same angular position each time its rotation is discontinued prior to depositing and/or picking up a tool, the spindle quill 20 is provided having a block or member 22 fixed thereto provided with a radially outwardly projecting V groove 23 extending lengthwise of the axis of the spindle. The groove 23 is adapted to be selectively engaged by a roller 24 on the upper end of a piston rod or plunger 25 fixedly connected to and projecting upwardly from a piston 26 of a fluid pressure operated motor, designated generally by the reference character M, and comprising a cylinder 27. The cylinder 27 is mounted upon an annular bracket 28 fixedly secured to the inner bottom portion of the spindle head housing 29. The piston 26 is biased by a spring 30 in a downwardly direction to normally maintain the roller 24 disengaged from the groove 23 carried by the spindle quill. The plunger 25, and in turn the roller 24, is moved in an upwardly direction to engage the roller 24 in the groove 23 by admitting pressure fluid to the end of the cylinder 27 underneath the piston 26.

The flow of pressure fluid to and from the cylinder 27 to engage and disengage the roller 24 with the groove 23 is under the control of a solenoid operated valve 35 fixedly secured within the spindle head adjacent to the cylinder 27 and connected thereto by a conduit 36 and to a source of fluid pressure by conduit means including the conduit 37. The valve 35 is normally closed, that is, in a position to connect a conduit 36 with exhaust and the solenoid thereof is energized to connect the motor M with the source of fluid pressure by a circuit including two magnet-type proximity switches 40, 41, the former of which is connected directly to the spindle head casting and the latter of which is connected to a projecting arm of the bracket 28, previously referred to.

The switches 40, 41 are adapted to be actuated to complete circuits therethrough by permanent magnet means 42, 43 carried by rings 44, 45, respectively, which rings are carried by the spindle quill and adjustable axially thereabout. The switch 40 is actuated by the permanent magnet means 42 so as to interrupt the spindle drive as by disconnecting the "spindle drive" motor from its source of power and plugging or otherwise braking it to stop with the groove 23 substantially aligned with the roller 24 carried by the piston rod 25 of the motor M. If the spindle stops, as anticipated, a circuit is completed through the solenoid valve 35 and the piston 25 extended to engage the roller 24 in the groove 23. The fact that the groove 23 is V-shaped moves the spindle to the exact desired annular position, if it is not therein when the roller 24 enters the groove, and the roller retains the spindle in the desired position until it is retracted from the groove 23. In the event the spindle has not stopped close enough to the desired position to allow the roller 24 to engage the groove 23 upon the functioning of the cam

control to deenergize the drive thereof, etc. the second proximity switch 41 will be connected in the circuit to the spindle drive motor such that the spindle will rotate until the switch 40 again functions. In other words, the switch 41 and its operating permanent magnet 43 senses the proximity or degree of accuracy with which the spindle stops or is about to stop and, if required, effects rotation of the spindle until the predetermined stopping accuracy is attained.

A pin 50 connected to the end of the piston rod 25 projecting above the cylinder 27 of the motor M and extending through a slot 51 in a guide bracket 52 through which the piston rod 25 extends, operates an electric switch 53 connected to the bracket 28 when the roller 24 is properly seated in the groove 23. The switch 53 is in a light circuit which provides a visual signal indicating that the spindle is in proper position for the replacing or picking up of a tool. If more positive means is desired for retaining the spindle in the desired fixed position than that provided by the engagement of the roller 24 in the groove 23, an electrically operated brake or the like may be employed either on the spindle or on the high-speed shaft 60 which drives the spindle through the flexible belt-drive, designated generally as 61. The machine shown incorporates a brake of this character connected to the high-speed shaft 60, which brake is generally designated by the reference character N. Since the particular construction and operation of the brake N forms no part of the present invention it is not illustrated and described in detail.

The tool holding devices L in the tool rack K are each preferably provided with means for holding the tools in predetermined angular positions in such rack and retaining the tool therein upon retraction of the spindle, such means comprising a spring-pressed detent adapted to engage in a hole in each of the arbors proper. The engagement of these detents in the holes of the respective arbors or tools in the various tool holding devices prevents the tools from falling out of or changing their angular position in the tool holding device of the rack incident to vibrations, etc. The construction also assures retention of the tool in the tool holding device upon retraction of the spindle incident to the operation of depositing a tool in the rack.

The tool rack shown comprises a stand 70 detachably bolted to the table E and having a tool carrying member or magazine 71 in which the tool devices L are directly supported, which member 71 is connected to the stand 70 for movement relative thereto in a direction parallel to the axis of rotation of the tool spindle 17. As shown, the magazine 71 is connected to the stand 70 by stud bolts 72 connected to the rearside thereof, as viewed in Fig. 1, adjacent each of the four corners of the member and projecting rearwardly through suitable apertures in the stand 70. The magazine 71 is biased away from the stand 70 by coil springs 73 surrounding the stud bolt 72 and interposed between the adjacent sides of the stand 70 and the magazine 71. As shown, the ends of the springs 73, which engage the stand 70, are located in counterbores so as to reduce the overhang of the magazine with respect to the stand. Movement of the magazine 71 in a direction away from the stand 70 is limited by nuts 74 threaded onto the rearwardly projecting ends of the stud bolts 72. These nuts 74 also provide means for adjusting the magazine 71 relative to the stand 70. Electric switches 75 located adjacent to the respective corners of the magazine 71 are fixedly secured to the stand 70 in such a manner that their actuating plungers are spaced slightly behind the rear side of the magazine 71. These switches are connected in series circuit with the main power supply for the machine and shut the machine down in the event that either of them is opened incident to the magazine 71 being moved towards the stand 70 while a tool is being placed in the magazine 71 or removed therefrom incident to some malfunction of the machine such as an error in the programming.

The spindle 17 is provided with an axially extending aperture, the forward portion of which forms a socket 80 having a slight taper to receive a tool or arbor T. The socket 80 terminates in a cylindrical bore 81 the diameter of which is about one-third that of the spindle. The bore 81 is connected by an axial bore 82 with a bore 83 extending to the rear end of the spindle. The socket 80 and bore 81 are adapted to receive the tool arbor T the taper of the shank 84 of which corresponds to the taper of the socket 80, and the rear cylindrical portion or pilot 85 of which fits into the bore 81.

The tool arbor T in the present instance is provided with a lock plug or member 86 threaded into a hole 87 in the arbor proper until a flange 88 formed thereon abuts against the rearward end of the arbor T. Alternatively, the member 86 could be formed integrally with the arbor. To the left of the flange 88, as viewed in the drawings, the part 86 is provided with a head 90 connected to the flange portion 88 by a reduced portion or neck. The portion of the head 90 adjacent to the neck is frusto-conical in configuration and provides a conical surface 91 diverging rearwardly with respect to the axis of the spindle, which surface is adapted to be engaged by mechanism for binding or locking the arbor T in the spindle socket. The other half of the head 90 is also frusto-conical in shape, but faces in the opposite direction.

The mechanism shown for locking or binding the arbor T in the socket 80 comprises a collet 92 positioned within the bore 81 and

threaded onto the forward end of a drawbar 93 extending from the bore 81 through the bore 82 where it is connected by a cylindrical member 94 to a tubular member 95 extending to the rear of the spindle. Reciprocation of the members 93 and 95 will move the collet 92 axially in the bore 81.

The collet 92 includes a plurality of spring or resilient fingers 96 each having a projecting wedge shaped portion provided with an inner inclined surface 97 and an outer inclined surface 98. The inner surface 97 of each wedge portion 96 is inclined with respect to the spindle axis so as to diverge rearwardly from the axis of the spindle and is adapted to engage the rearwardly diverging surface 91 on the member 87 when the collet 92 is in its binding or locking position. The outer inclined surface 98 of each finger 96 also diverges rearwardly and engages an annular rearwardly diverging abutment surfaces 100 on a flange extending inwardly from the inner wall of a bushing 101 fixed within the bore 81 of the spindle.

The abutment surface 100 diverges rearwardly with respect to the axis of the spindle with its acute angle of inclination preferably being less than the acute angle of inclination of the surface 91 of the adapter. The inner surfaces 97 shown are inclined at an angle of 30° to the axis of the spindle and the outer surfaces 98 at approximately 20°. The angles of inclination of the surfaces 91, 100 correspond with those of the surfaces 97 and 98, respectively. In the binding position of the collet the wedge shaped portion of each of the fingers 96 acts as a wedge, operating between the fixed abutment surface 100 carried by the spindle and the inclined surface 91 of the adapter 87.

The collet 92 is continuously urged to a retracted or wedging position, shown in Fig. 5, wherein it is adapted to lock the arbor T in the spindle socket by a spring means in the form of a plurality of heavy oppositely facing concave-convex disk-like spring members 102 positioned in the bore 83. The spring members 102 are interposed between the cylindrical member 94 fixed to the end of the drawbar 93 and a shoulder formed by the bottom of the counter bore 83.

To release the arbor T from the spindle socket 80, the collet 92 is moved forwardly in the bore 81 to move the wedge portions of the fingers 96 from between the fixed inclined surface 100 of the spindle and the inclined surface 91 of the member 87 and to position the wedge portions in the bore 81 forwardly of the shoulder forming the forward or right-hand side of the internal flange of the member 101 upon which the inclined surface 100 is formed. With the wedge portions of the fingers 96 forward of this shoulder, the fingers 96 will expand when the arbor is moved outwardly and permit the withdrawal of the arbor T from the spindle socket. As the collet 92 is moved forwardly by the drawbar 93 the forward portion 103 of the drawbar, which projects into the collet, functions as an ejector or abutment member and strikes the rear or left-hand end of the member 86 to unseat the arbor T from the socket 80. The movement of the ejector 103, after it engages the end of the member 86, need only be sufficient to break the arbor away from its seat in the socket 80.

The collet 92 is moved forwardly with respect to the spindle 17 from its rearward locking or binding position in bore 81 to its forward releasing and ejecting position by a fluid pressure (preferably air) actuated reciprocating type motor P having a piston assembly slidable in a cylinder fixed to the slide 105 which reciprocates the spindle, adjacent to the rearward end of the spindle. The piston assembly comprises a plurality of pistons 106 assembled upon a sleeve 107 and held in predetermined spaced relation to a flange or shoulder adjacent to the right-hand end of the sleeve, as viewed in Fig. 6, and to each other by a plurality of sleeve-like spacers, one of which is interposed between the shoulder on the sleeve 107 and the first piston 106, and the others of which are interposed between the various pistons with the exception of the last or left-hand sleeve which is located to the left of the left-hand piston and is abutted by a jam nut 111 which fixedly secures the pistons and the spacing collars to the sleeve 107. The sleeve 107 is slidably supported upon a cylindrical boss 112 projecting to the right from a disk 113 which forms a part of the motor assembly P. A two-part adjustable nut 114, 115 is located within the sleeve 112 and has threaded engagement with the spindle reciprocating lead screw 116. The right-hand nut portion 114 is keyed to the sleeve 112 and the left-hand nut portion 115 is connected to the disk 113 for angular adjustment relative thereto for the purpose of taking up backlash between the nut and the spindle feed screw 116.

While the disk 113 does not constitute a cylinder head for the fluid pressure actuated motor P, it may be considered a part of the cylinder assembly. In addition to the disk 113, the cylinder assembly comprises a plurality of cup-shaped members 117, the axial flanges of which space the bottoms or radial flanges thereof in predetermined relationship. The construction is such that a radial flange is positioned to the left of the left-hand piston 106, to the right of the right-hand piston 106, and between the intermediate pistons. The right-hand cup-shaped member 117 is provided with a flange 118 projecting to the right as viewed in Fig. 6 and through the medium of which it is bolted to the left-hand end of the spindle feed slide 105. The piston assembly is slidable relative to the cylinder

assembly and the relatively movable surfaces are sealed by suitable O-ring seals.

The construction shown is as described and claimed in Specification 852,459 and provides five tandem fluid pressure operated reciprocating type motors connected by suitable conduit means including headers and ports, in such a manner that they are double-acting. The headers which are formed within the cylinder assembly are connected by suitable tubing 126, 127 to a three-way solenoid operated valve 128 adapted to control the flow of fluid pressure to and from the cylinders of the motor.

The right-hand end of the sleeve 107 of the piston assembly is counterbored as indicated by the reference character 130 to receive a small amount of clearance and a flange-like member 131 fixedly secured to the rear or left-hand end of the tubular member 95. The construction is such that when fluid pressure is admitted to the fluid pressure operated motor P in the direction to move its piston assembly toward the right, the shoulder formed by the counterbore 130 abuts against the left-hand end of the member 131 and pushes the members 95, 94, 93, and in turn, the collet 92 to the right to release and unfreeze the tool arbor T from the spindle socket 80. Upon release of the pressure fluid from the tubing 126, pressure fluid is preferably applied through the tubing 127 to the opposite side of the pistons 106 for a short interval of time for the purpose of moving the sleeve 107 free of the member 131, there being a small clearance provided between the abutting surfaces of these members when they are in their respective left-hand positions. The purpose of this clearance is to eliminate the wear which might otherwise occur.

Fluid pressure, preferably air, is supplied to the solenoid operated valve 128 by a conduit 132 leading to an air supply. The valve is supported in the rear end of the spindle head in a suitable manner and the operation thereof to control the flow of fluid pressure to the motor O in the direction to release the spindle binder is controlled by a push-button switch located at a convenient position near the front or tool end of the spindle head where it is readily accessible to the operator while he is holding the tool arbor in the spindle socket, or by the punched tape control unit H. The supply of fluid pressure to the motor or motors for moving the piston assembly free of the rear end of the spindle assembly, is preferably automatic, but only for a short duration, upon the release of pressure fluid from the opposite end of the motors. This can be readily accomplished by suitable switching means including a time delay mechanism.

While a specific power operated mechanism for binding the tool or tool arbor in the spindle is herein shown and described in considerable detail, it is to be understood that any such suitable mechanism could be employed.

While the preferred embodiment of the invention has been described in considerable detail it will be apparent to those skilled in the art to which it relates that the invention is not limited to a particular type of machine or to the type of machine shown having the particular construction described, and that the invention can be otherwise embodied, for example, the invention is equally applicable to vertically typed boring machines and various types of automatic programming equipment other than punched tapes including but not limited to punched card and magnetic tape controls.

It is also to be understood that the invention contemplates means other than that shown for yieldably supporting the tool holding devices or magazine and shutting down or stopping the machine and more particularly the relative movements between the tool carrier or spindle and the tool magazine in the event of improper contact occurring therebetween.

WHAT WE CLAIM IS:—

1. A machine tool having a rotatable tool carrying member adapted to have a tool detachably keyed thereto and a work carrying member movable relative to one another both transversely of the axis of rotation of the tool carrying member and lengthwise of said axis and capable of automatically performing a series of machining operations on one or more work pieces carried by the work carrying member, characterized by means for automatically programming a series of machine operations and being effective to align the tool carrying member and a predetermined one of a plurality of tool holding devices in a tool rack to permit the tool carrying member to receive one of the tools held by the tool holding devices, and means operatively connected to the tool carrying member for stopping said tool carrying member in substantially the same angular position each time its rotation is discontinued prior to depositing a tool or picking up a tool from the tool rack.

2. A machine tool according to claim 1, characterized by the fact that each of said tool holding devices is provided with means for holding the tools in predetermined angular positions in the rack.

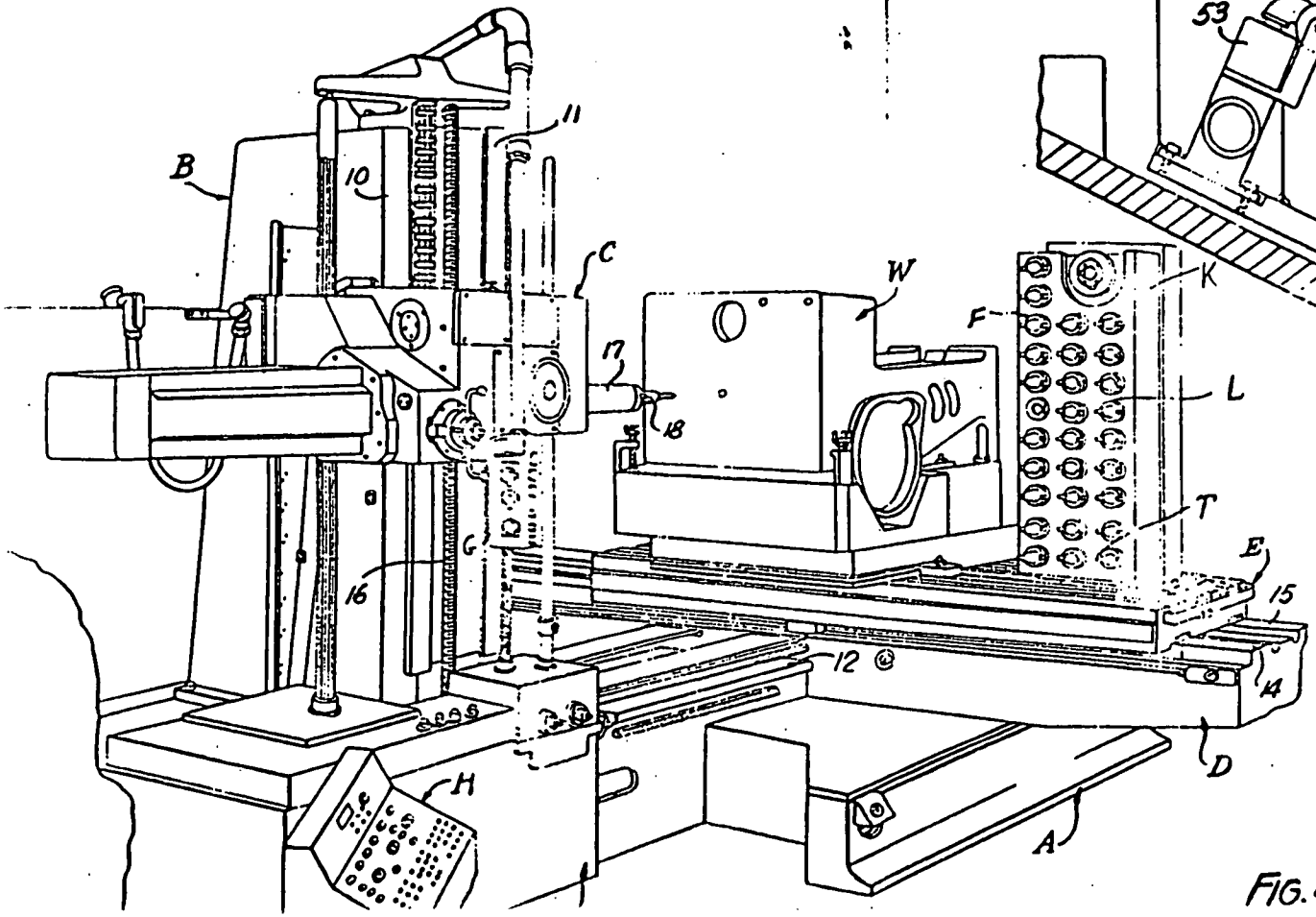
3. A machine tool according to claim 1 characterized in that said last named means includes switch means effective to maintain said tool carrying member in rotation until said angular position of said tool carrying member is reached.

4. A machine tool according to any one of the preceding claims, characterized by power actuated mechanism in the tool spindle for engaging and disengaging tools in said tool holding devices.

5. A machine tool as substantially hereinbefore described with reference to the accompanying drawings.

STEVENS, LANGNER, PARRY & ROLLINSON,
Chartered Patent Agents,
Agents for the Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1962.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.



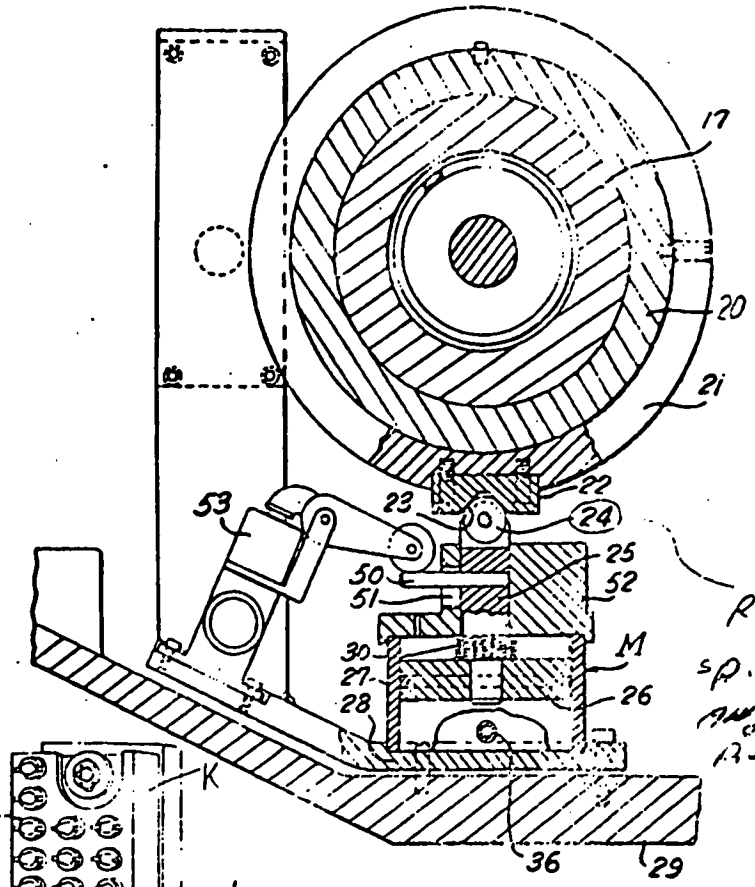


FIG. 3

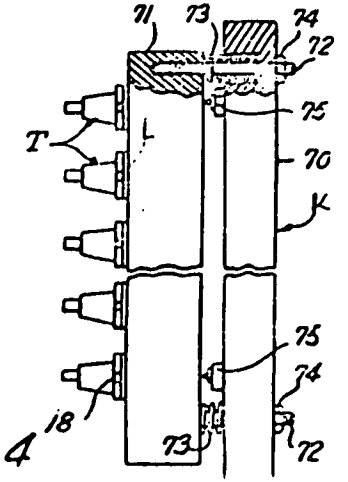


FIG. 4

Roller engages spindle in predetermined position

Z. R. BILINSKY

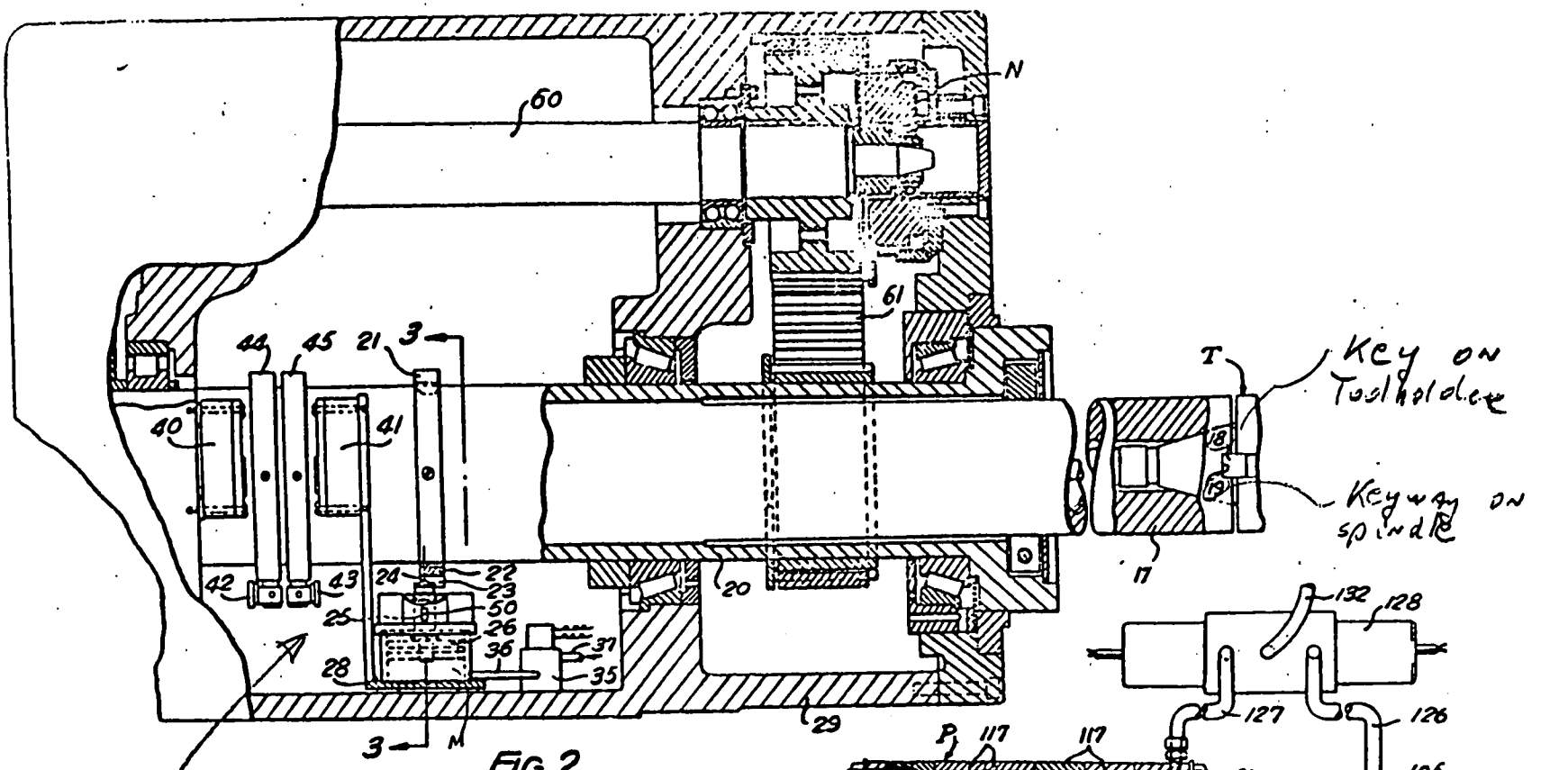


FIG. 2

Spindle angular stop means.

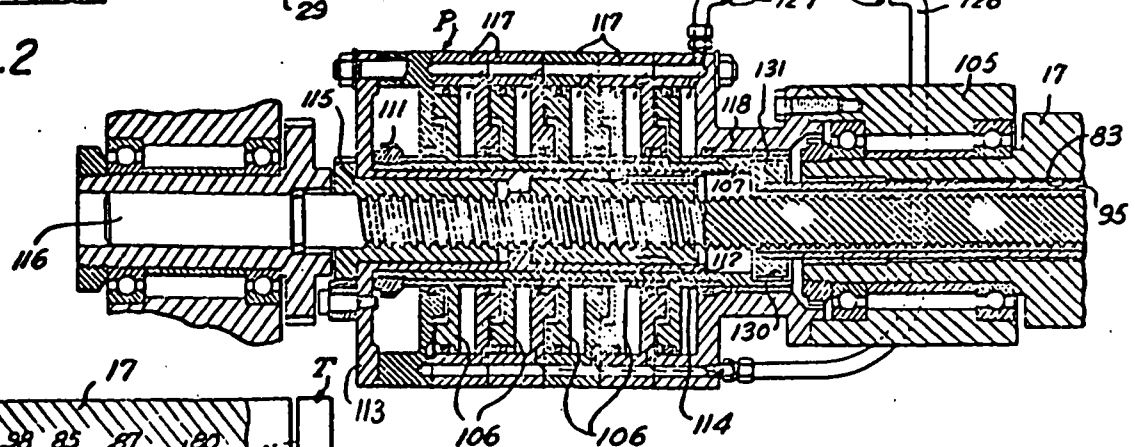


FIG. 6

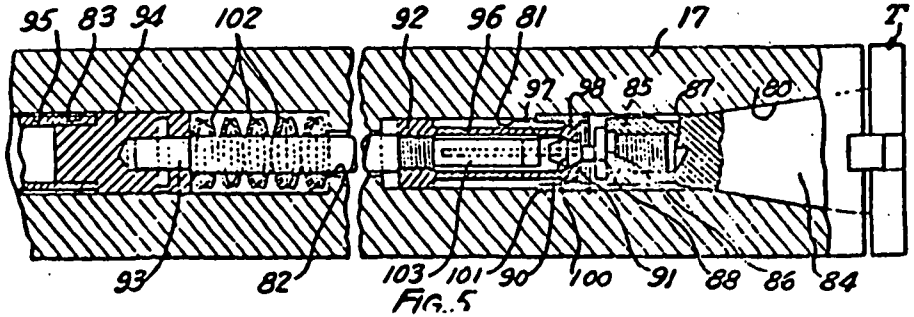


FIG. 5